Ain-Shams University
Faculty of Science
Chemistry Department

Physicochemical studies on some photochromic glasses containing transition metal oxide

A THESIS

Submitted to
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Faculty of Science
Ain-Shams University

By

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For
Ph.D degree of Science
(Chemistry)

2011

APPROVAL SHEET FOR SUBMISSION

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Title of Thesis: physicochemical studies on some photochromic glasses containing transition metal oxide

Degree : Ph. D degree, Faculty of Science, Ain Shams University, 2009

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PHYSICOCHEMICAL STUDIES ON SOME PHOTOCHROMIC GLASSES CONTAINING TRANSITION METAL OXIDE

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Acknowledgment

My grateful thanks are due to the many people who have given of their time and assistance towards the completion of this thesis.

I would like deeply to express my thanks to ***Prof. Dr. E. A. Saad****, Department of chemistry, Faculty of Science, Ain-Shams University, for his supervision and continuous encouragement throughout the present work.*

I am deeply grateful to Prof. ***Dr. F. A. Moustaffa****, Glass Research Department, National Research Center, for suggesting the problem, supervision, effort and advice he readily gave during the progress of this work.*

I am deeply indebted to ***Dr. F. A. El-Batal****, Assic. Prof., Glass Research Department, National Research Center, for her guidance, supervision and interest through out the course of this work.*

Special thanks are to the president and vice-president of National Research Center for financial support to complete this work. And all my colleagues in Glass Research Department, National Research center for their valuable cooperation.

جامعة عين شمس
كلية العلوم
قسم الكيمياء

دراسة على بعض انواع زجاج الفوتوكروم المحتوى على العناصر الانتقالية

من
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المركز القومى للبحوث

ماجستير علوم (غير عضوية) ٢٠٠٦
جامعة القاهرة

للحصول على درجة
دكتوراه الفلسفة فى العلوم (غير عضوية)

٢٠١١

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الجامعة : القاهرة

سنة التخرج :١٩٩٨

سنة المنح : ٢٠٠٦

Б ʒC'5ŊJFɳɛŶ
ʒDžŽiFN5
oŶʒNŽiƐɓţ

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عنوان الرسالة : دراسات فيزيقوكيميائية على بعض انواع زجاج الفوتوكروم المحتوى على العناصر الانتقالية

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ثم الاشخاص الذين تعاونوا معى فى البحث و هم

الزملاء و الزميلات فى قسم بحوث الزجاج بالمركز القومى للبحوث

و كذلك الهيئات التالية

المعامل المركزية بالمركز القومى للبحوث

Abstract

Physico-chemical investigations on some prepared Na-borosilicate glasses containing 0.4 AgBr and 0.04 Cu_2O, and also one of transition metal oxides, NiO, CoO, Cr_2O_3, TiO_2 have been carried out in order to throw some light on the structure of the studied glasses and possibly the forms in which each transition metal can exist in the glass.

All the glasses studied were melted in platinum-2% rhodium crucibles in an electrically heated furnace at 1450°C for two hours.

The results obtained could be explained when it was realized that the state of the transition metal ions existed in the glass depends on several factors such as:

1. The polarizability of the oxygen ligands surrounding transition metal ion.
2. The mobility of the alkali ions and their field strength.

The appearance of the absorption visible band at (440-455) nm indicates the existence of Ag-aggregate after heat treatment the glass samples at 600 ºC for one, three or six hours.

Key words: Spectrophotometric studies; Sodium borosilicate glasses; Silver ions; copper ions; Photochromic glass; transition metal oxides.

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I. Introduction

Glass is considered as one of the most important materials, it plays an important role in our life for its great contribution in both scientific research and industrial applications. As a matter of fact, the glass technology has grown up largely on empirical basis, separated some how from the scietific approach ; but the workers in this field found themselves forced to fill the apparent gap between the science and the technology in the study of the glass strucrure. However, during the last three or four decades, the efforts have been made in order to investigate and identify glasses from the scientific point of view. Therefore, it is easy now to speak in scientific terms about the glass word as well as about a substance in the glassy state. Without a thorough knowledge of the relationship between the structure and the glass properties, no important progress is any longer possible. This has been recognized and the modern glass research establishment is being set up all over the world.

I.1. Brief history of glass

The history of glass is summarized in articles in the Encyclopedia Britannica and also by **(Morey 1954, Newton and Davison 1989).** Natural glasses have been used from the earliest times for which there is archeological evidence. Glass and glazes were manufactured far back in the human history. The earliest known glaze dates from about 12000 B.C. and the earliest pure glass from about 7000 B.C. ; both were found in Egypt. Many of the beautifully stained windows, which can still be viewed in a number of churches over the European continent, show the deep commitment of the church to preserve the history of the mankind and the

religious teachings through the medium of the glass. At first the glass was used only for the decorative objects, but later it was molded or pressed into vessels. The invention of the glass blowing in about the first century B.C. greatly increased the use of the glass for the practical purposes in Roman times. In the west, the glass manufacturing was dispersed to isolated sites after the fall of the Roman Empire, but it was continued in Byzantium and later in the Middle East by the Arabs. Progress in the techniques of the glass manufacture and in the application of the glass was subsequently rapid, in parallel with many other areas of technology. Until the twentieth century most of these advances were made empirically, using common sense to guide experimentation. The application of the basic scientific understanding to the improvement of manufacture and to the new application of glass has occurred only in the last few decades. Many uses of the glass in the modern world continue to exploit the transparency, lustre and durability properties of the glass. Containers, windows, lighting, insulation, fibers, stemware and other hand-crafted art objects are typical of these traditional uses. At this point, it is worth noting that for a material to be used in the product, it must have certain desirable properties that determine its use. Through the application of the basic science to the study of the glass, newer properties of different types of glasses have been developed, and hence, newer products have been conceived. Some of the areas of the glass science that have been most active in the last few years are sol-gel fabrication, zirconium fluoride glasses, optical wave guides, reactions of water with glass, nonlinear optical properties, laser glass and many new types of photochromic glasses.

This brief survey of the history of the glass science is not intended to be exhaustive, and many deserving names and studies have undoubtedly been omitted. The next decades should see a continued expansion of